Robot Task Space Analyzer

Developer: University of Tennessee
Contract Number: DE-AR26-97FT34314
Crosscutting Area: Robotics

Deactivation & Decommissioning
FOCUS AREA

Problem:

Many Department of Energy (DOE) environmental restoration and waste management projects will involve radiation or other hazards that necessitate the use of remote operations to protect human workers from dangerous exposures. Remote work is slow and tedious due to difficulties of remote manipulation and viewing. Facility deactivation and decommissioning (D&D) involves complex cutting, handling, and sorting tasks that may take tens-to-hundreds of times longer than equivalent hands-on work. New and fundamental technologies are needed to increase the efficiency of remote operations and reduce costs.

Solution:

A promising way to achieve increased remote worksystem efficiency is to layer telerobotic technologies onto teleoperated remote systems. Best available remote worksystems use pure teleoperation in which a single human operator performs all operations through remote control and viewing interfaces. Telerobotics research seeks to improve this baseline by allowing operators to automate subtasks. Subtask automation will decrease task time while enhancing safety and work quality.

Before subtask automation can be exploited, it is necessary to model the 3-D geometry of the task space scene surrounding the remote worksystem. This precision description of where objects are located in the task space is rarely available beforehand. It must be generated at the work site by interactive sensor systems associated with the robot. The Robot Task Space Analyzer (RTSA) is a potential integrated sensor subsystem capable of obtaining the data necessary for subtask automation.

Benefits:

RTSA will reduce the costs of operating remote equipment in D&D projects by:

▸Reducing remote task execution time

▸Reducing the number of system operators

▸Improving work quality in repetitive and tedious tasks

▸Facilitating enhanced operational safety

RTSA is an enabling technology necessary for the deployment of telerobotic automation in D&D. It is conservatively estimated that effective telerobotics systems can increase the productivity of D&D remote operations by 10 to 30%. If only 10% of the projected D&D projects involve remote operations, telerobotic savings enabled through the RTSA could be in the range from tens to hundreds of millions of dollars.

Technology:

RTSA will be a collection of software processes running on a computer in the operator's console and linked to physical devices on the remote worksystem. It will be organized into modules that provide a full spectrum of options to the operator for the fast and efficient creation of task space 3-D models.
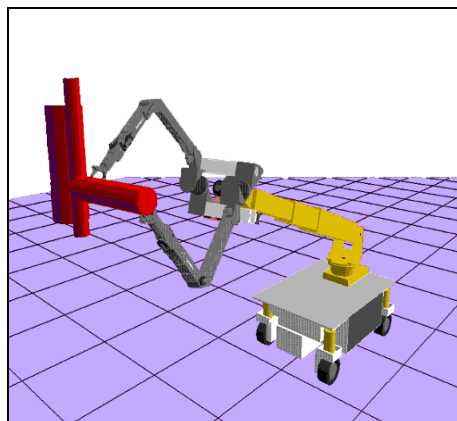
The RSTA combines laser and stereo imaging, human-interactive modeling, and semi-automatic object recognition to build a 3-D model of the work zone in which a robot system is operating. In future telerobotic worksystems, RTSA results will be accessed by automatic collision checking and motion planning routines to automate subtask execution.

Prior work in human-interactive stereo at the Oak Ridge National Laboratory (ORNL) and interactive 3-D object recognition from laser range camera images at the Carnegie Mellon University will be used as a foundation for RTSA. The project will emphasize the human factors aspects of the interactive software.

The RTSA project will initially focus on the development and evaluation of the components in the laboratory. In the optional phase, the system will be integrated with a working telerobot at a DOE site for full-scale evaluations.

Contacts:

Researchers at the University of Tennessee have been developing control strategies for advanced telerobotic systems for over 10 years. They have worked closely with ORNL and other national laboratories, and NASA on the development and implementation issues for remote manipulation systems. For information on this project, the contractor contact is:

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Base Phase Start — Development — Lab Test — Option I — Contract End — Gate 5